THE AORTA AND ITS INTERACTION WITH THE HEART IN MIDDLE-AGED INDIVIDUALS: GENDER MATTERS

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Introduction

The Asklepios study is a large longitudinal study aiming to better understand the determinants, development and progression of cardiovascular disease in the general population. First round data were obtained in 2002-2004 in middle-aged individuals (35-55 years old); second round measurements are ongoing. Here, we report our findings on aortic and arterial system properties and ventriculo-vascular coupling using cross-sectional 1st round data.

Methods

Arterial impedance and wave reflection analysis was based on non-invasively acquired carotid pressure (applanation tonometry) and central flow waveforms (pulse Doppler ultrasound). Carotid-femoral pulse wave velocity (PWV) quantified aortic stiffness. In 1214 (551 F/ 663 M) out of 2026 subjects (1052 F/ 974 M), cardiac ultrasound and speckle tracking further allowed to assess time-varying left ventricular dimensions and to estimate peak/end-systolic myocardial stress and the ejection-phase stress-time integral.

Results and discussion

Aortic and arterial properties

PWV increased by 15% (from 6.1 to 7.0 m/s) both in men and women over the measured age range. In qualitative terms, input impedance evolved from a pattern indicative of wave transmission and reflection to a pattern more compatible with a windkessel-like system (Figure 1).

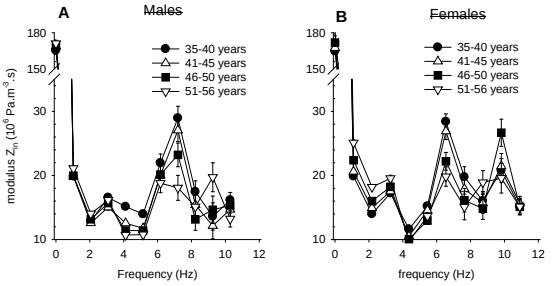

Figure 1. Evolution of input impedance in males (left, panel A) and females (right, panel B)

In women, a decrease in total arterial compliance led to an increased input impedance in the low frequency range, whereas few changes were observed in men. Characteristic impedance did not change with age in women and even decreased in men ($P<0.001$). Reflection magnitude increased with age ($P<0.001$) without gender differences.

Ventriculo-vascular coupling

For any given end-diastolic left ventricular geometry and cardiac output, peak myocardial stress correlated directly with systemic vascular resistance (standardized $\beta=1.12$; $P<0.001$) and aortic characteristic impedance (standardized $\beta=0.17$; $P<0.001$). The ejection-phase stress-time integral correlated with systemic vascular resistance (standardized $\beta=1.06$; $P<0.001$), lower total arterial compliance (standardized $\beta=-0.13$; $P=0.0008$), and earlier return of wave reflections (standardized $\beta=-0.10$; $P<0.001$) but not with reflection magnitude, whereas end-systolic wall stress correlated with systemic vascular resistance (standardized $\beta=1.06$; $P<0.001$) and reflection magnitude (standardized $\beta=0.12$; $P<0.001$). After adjustment for age, all of the measured arterial properties, end-diastolic left ventricular geometry, and cardiac output, women demonstrated greater peak, end-systolic, and ejection-phase stress-time integral.

Conclusion

Aortic and arterial system properties seem to evolve differently with age in middle-aged men and women. Impedance analysis reveals a more pronounced decrease in total arterial compliance (which is not mirrored by PWV).

Women further demonstrate higher left ventricular wall stress development for any given left ventricular geometry, arterial properties, and flow output. These observations may relate to the differential susceptibility of women to heart failure.